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# A Passive RFID Implant for Soft Tissue Trauma Monitoring

**J.M. Rigelsford and C. J. Davenport**

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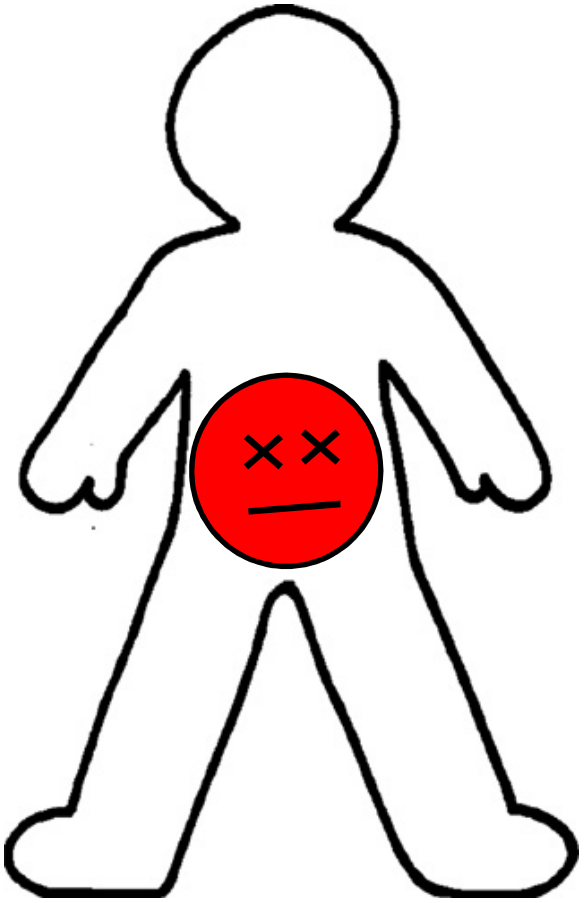
# Background

Soft tissue damage deep within the human body can occur for a number of reasons:

- road traffic accidents,
- extensive surgery for cancer treatment (e.g. colorectal cancer),
- or shrapnel wounds caused by military combat operations or terrorist attacks.



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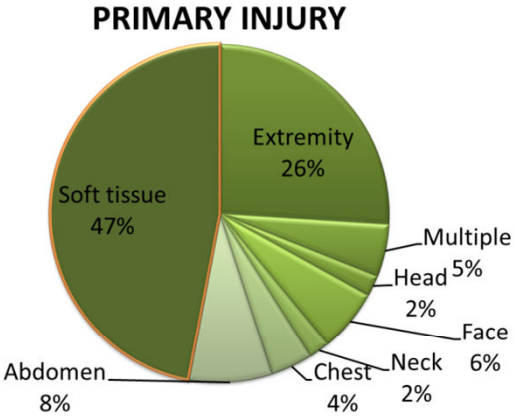
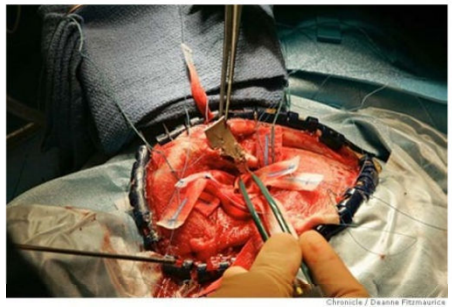
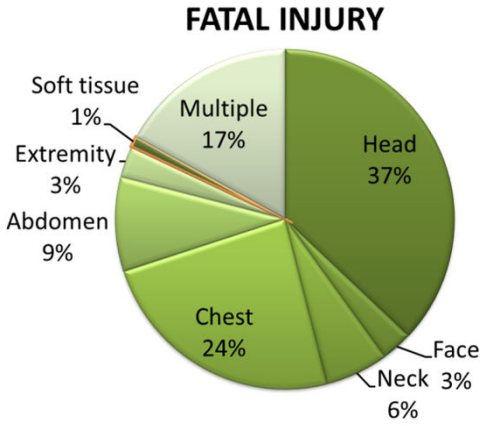
# Statistics

41,000 people in the UK are diagnosed with colorectal (bowel) cancer each year.

In the Gulf War (1990-91) 80% penetrating wounds on British personnel were caused by fragments from explosive munitions such as shells, grenades and improvised explosive devices, rather than bullets.





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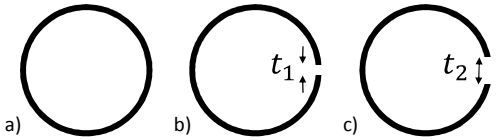
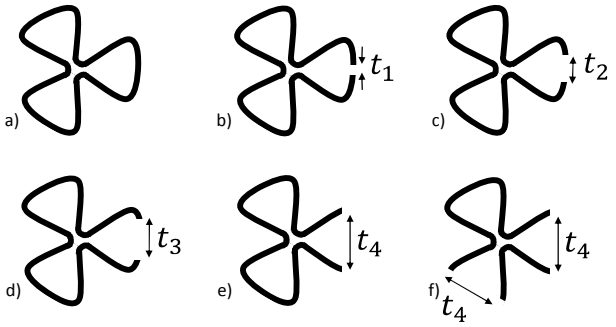
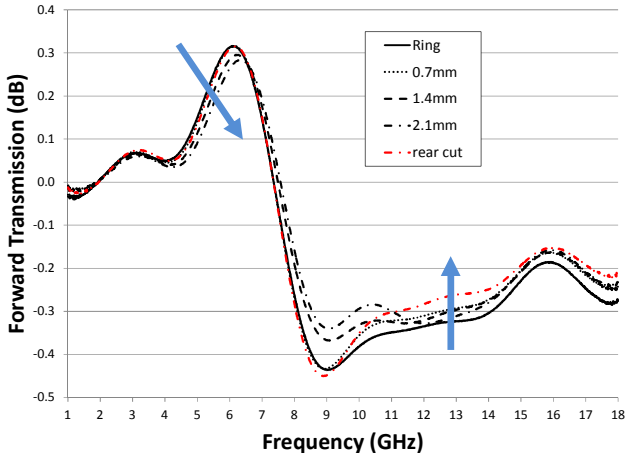
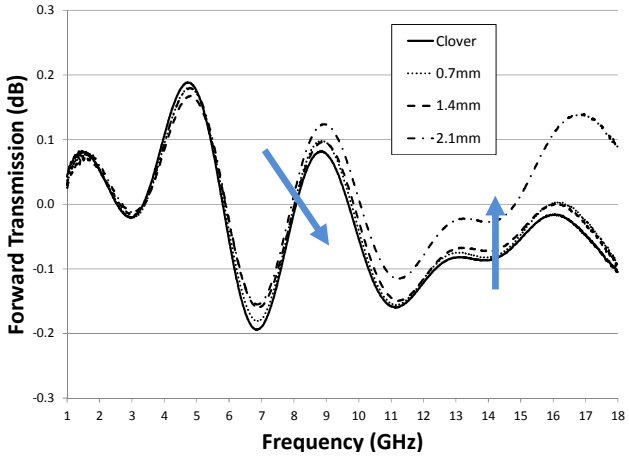
# Results

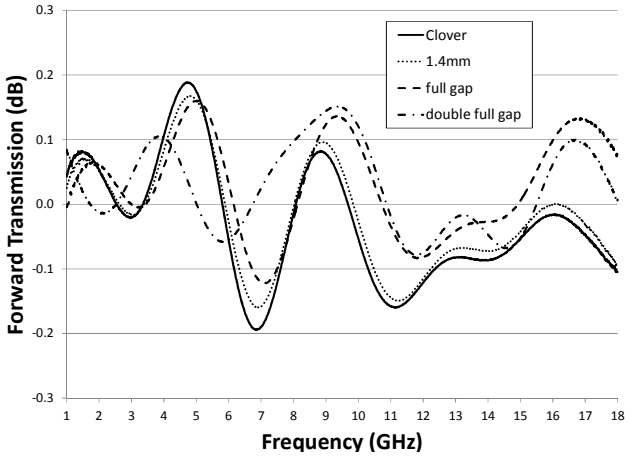
| Parameter | Dimension (mm) |
|---|---|
| $t_1$ * | 0.7 |
| $t_2$ * | 1.4 |
| $t_3$ * | 2.1 |
| $t_4$ * | 5 |
| $s_1$ | 0.7 |





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# Thank you!

# A Passive RFID Implant for Soft Tissue Trauma Monitoring

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## Abstract

This work presents the design of a passive RFID tag which can be used to monitor patients who have suffered from soft tissue trauma. Such traumas can occur due to road traffic accidents, extensive surgery due to cancer treatment, or shrapnel wounds caused by combat or terrorist attacks. The subcutaneous RFID implant passively monitors the healing rate of the patient and can be used for the early detection of infection. Unlike conventional designs, as the device is biodegradable, there is no need for further post-operative surgery to remove it. The effect of micro-fractures on ring and clover shaped RFID tags are summarized by experimental results.

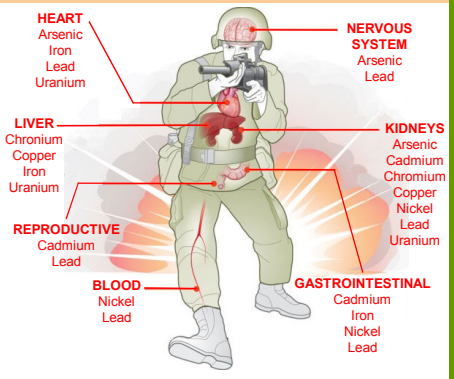
## Background

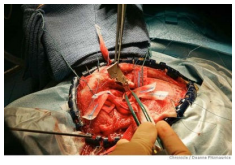
Damage to soft tissue deep within the human body can occur for a number of reasons, from road traffic accidents, extensive surgery for cancer treatment (e.g. colorectal cancer), or shrapnel wounds caused by military combat operations or terrorist attacks.

## CANCER

Colorectal (bowel) cancer is the UK's third most common cancer with 5% of the population developing bowel cancer during their lifetime. More than 41,000 people being diagnosed with the disease annually, and approximately 16,000 people die of the disease each year.

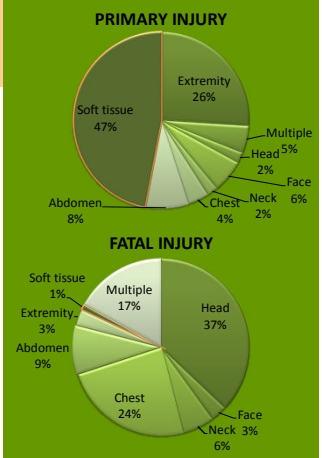
Regular bowel cancer screening has been shown to reduce the risk of dying from bowel cancer by 16%.



## COMBAT

In the Gulf War (1990-91) 80% penetrating wounds on British personnel were caused by fragments from explosive munitions such as shells, grenades and improvised explosive devices, rather than bullets.



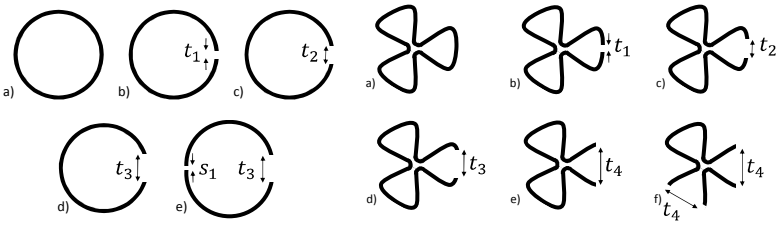

Beyond shrapnel damage, tissue healing may also be delayed by metal poisoning from the shrapnel itself.

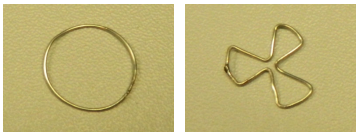
## The Challenge

The problem with all invasive surgery is the route for potential infection. In all such cases it can be very difficult to monitor the healing process within the body after surgery has occurred. Soft tissue damage is not easily monitored using X-Rays, and access to MRI scanners is limited or non-existent in many parts of the world. For abnormal patient recovery, diagnosis of complications may only be achieved through further exploratory surgery after the patient has become acutely symptomatic. Additional surgery is obviously unpleasant for the patient, has an additional risk of infection, and is very costly in terms of time and resources. To mitigate against infection, strong or extensive doses of antibiotics can be prescribed, but it has been widely publicized that the range of currently available effective antibiotics is reducing due to resistant strains of bacterium.

## Results

Experimental results have been presented for a non biodegradable ring and clover shaped RFID tag. The results demonstrate that degradation of the shapes can be remotely monitored by tracking changes over a broad frequency range.



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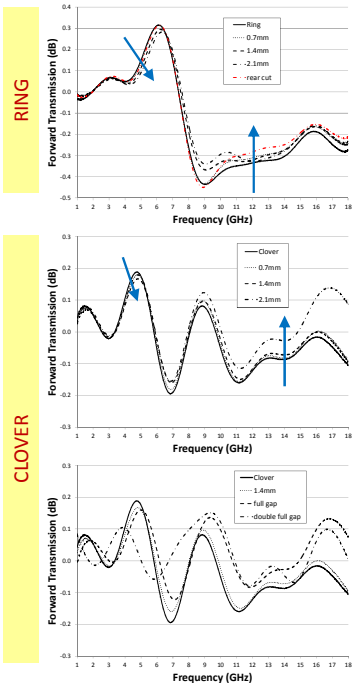



## PROTOTYPE PASSIVE RFID TAGS

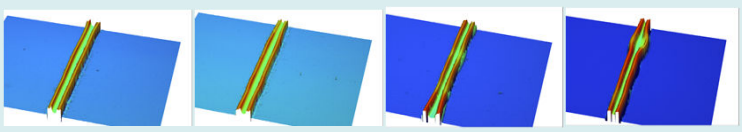
In order to validate the ring and clover designs, two non-biodegradable RFID implants were manufactured and tested experimentally. The ring and clover designs are shown in their initial states prior to degradation.

The ring was designed to resonate at 6 GHz, and the clover at 5 GHz. Prototypes for both the ring and clover shaped rings were manufactured from 26 gauge (0.4 mm) zinc plated copper.

Both were made electrically continuous using lead-free solder and were degraded by carefully cutting and removing small amounts of material from around the soldered joint.

## BEYOND THEORY

By changing the thickness and width of printed tracks, break points can be designed to ensure that degradation occurs in a controlled manner.



Step height 1.35 µm
Width 48 µm
80/700/720

Step height 1.21 µm
Width 52 µm
Laser sintered
80/700/720

2 depo-sinter layers
Step height 1.82 µm
Width 70 µm
80/700/720

3 depo-sinter layers
Step height 2.5 µm
Width 70 µm
80/700/720 laser

## Conclusions

This work has presented the concept of a passive RFID tag which can be used to monitor patients who have suffered from soft tissue trauma. The subcutaneous RFID implant could be used to passively monitor the healing rate of the patient and can be used for the early detection of infection.

Future work will concentrate on developing bio degradable versions of the tag and optimizing their degradation signatures. A toxicology study of the materials used for the implantable RFID tags is also envisaged.

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